



OBPR

*Office of Biological and
Physical Research*

Microgravity: Unique Opportunities in Basic and Applied Biological Research

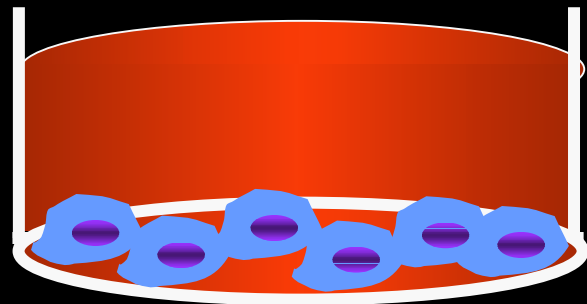
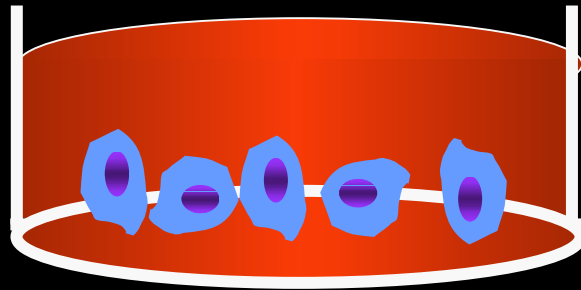
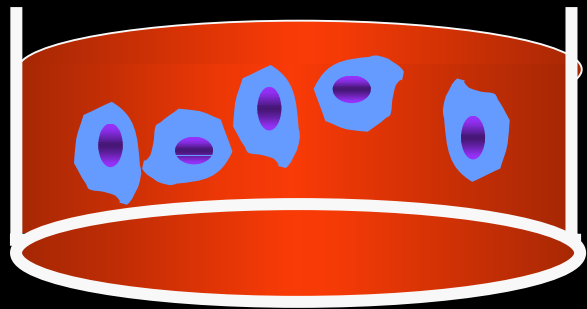
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Why Conduct Cell Culture in Space?

- Space exploration will result in the transitioning of terrestrial life to low gravity environments
- Investigating the cellular response to microgravity reveals novel adaptational mechanisms
- Novel mechanisms enhance our opportunities in applied science

1 G Cell Culture



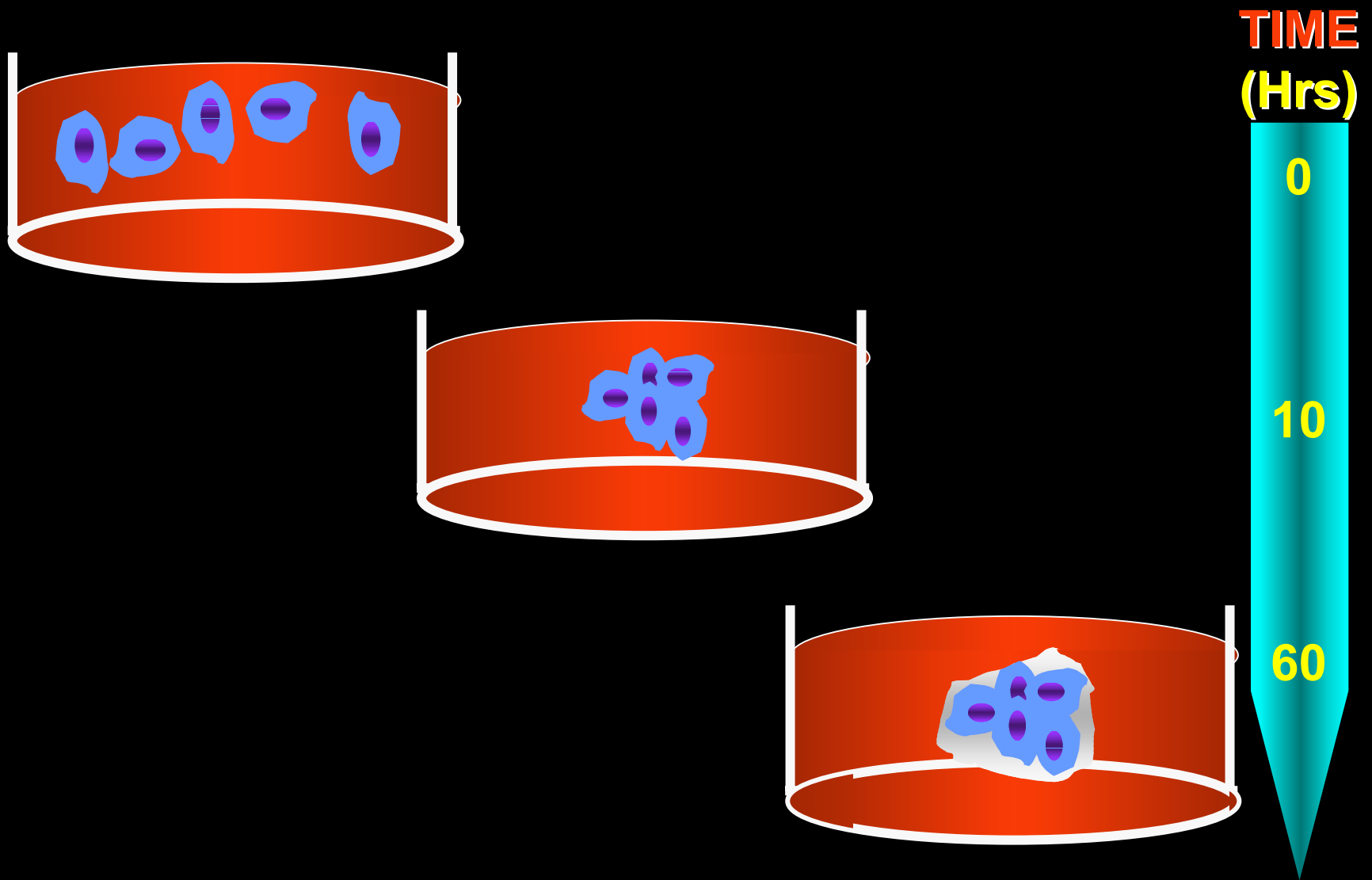
TIME
(min)

0

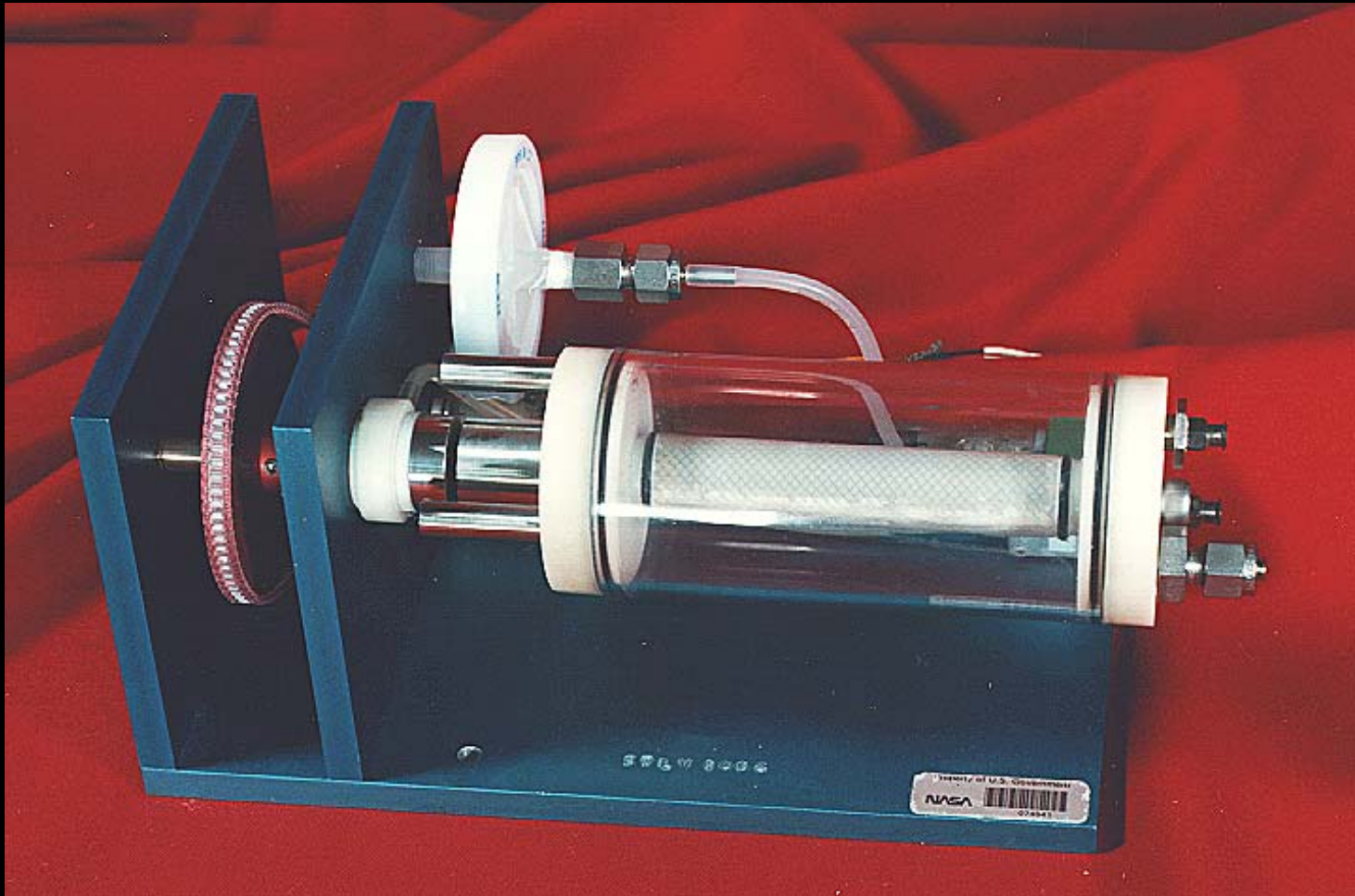
10

60

Microgravity Cell Culture



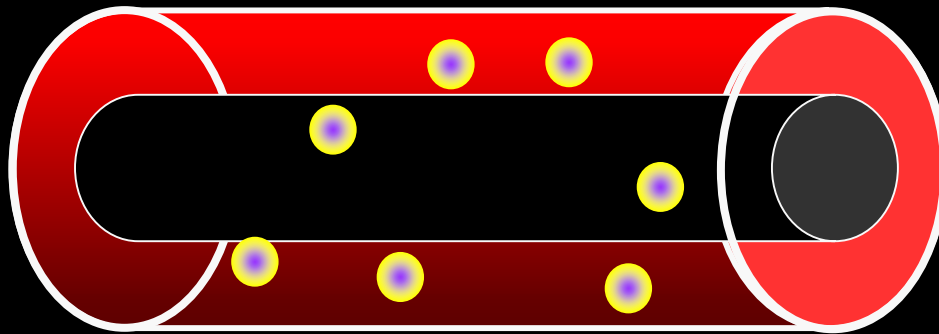
NASA Rotating Cell Culture System



Licensed to Synthecon, Inc.

Microgravity Analog Culture

Solid Body Fluid Rotation



Basis of operation

Zero head space

Fluid rotates with the cylinder

Results in particle suspension without stirring

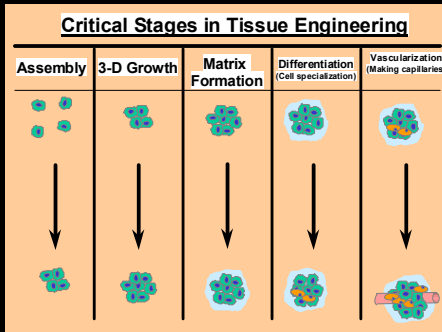
Derivative of clinostatic rotation

Low shear (0.3 dynes/cm²)

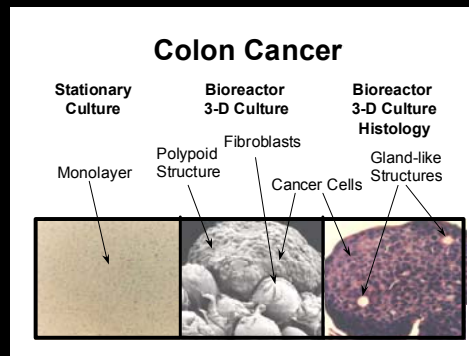
Microgravity Cell Culture Strategy

Use NASA technology and the microgravity of space to provide a unique cell culture settings that address applied and fundamental cell science challenges.

Tissue Engineering



Models of Human Disease



Vaccine and Drug Development

Microbial Growth

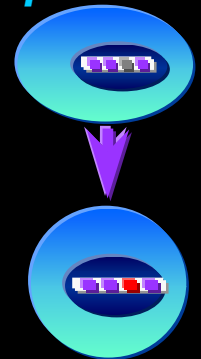


Space Cell Biology

Gene Expression

1 G

Micro G



Ground-based Technology Development

NASA Bioreactor– Flagship Technology

21 patents (19 licensed)

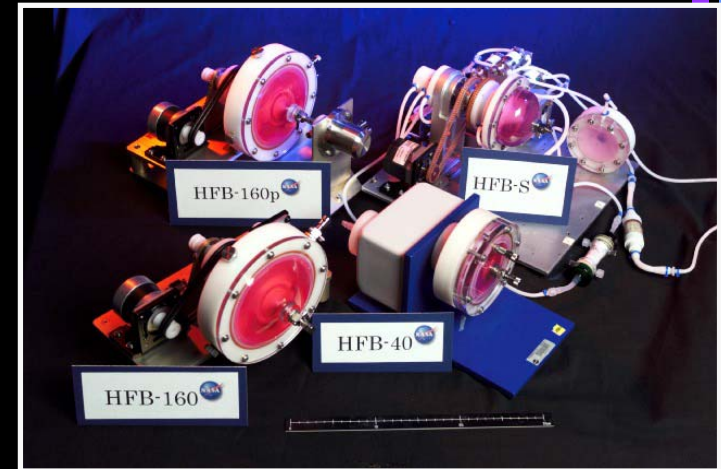
5 patent applications pending

8 invention disclosures

Hydrodynamic Focusing Bioreactor (HFB)

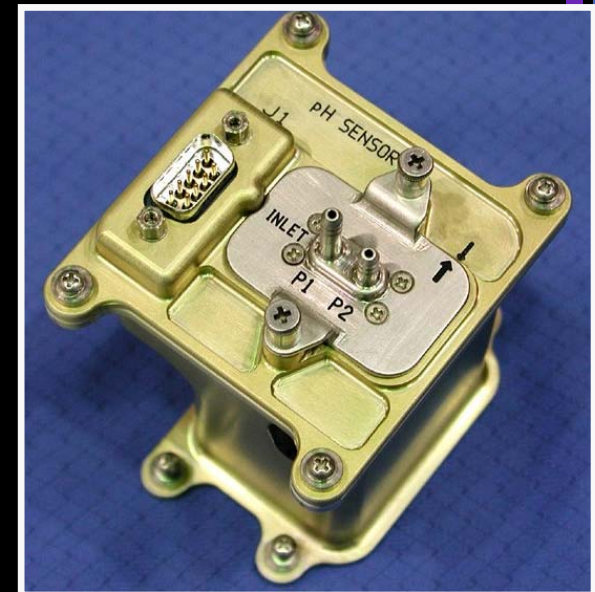
Three-phase evaluation

Space Bioreactor (HFB-S) development



Advanced Sensors – Dr. Antony Jeevarajan

- Non-invasive optical pH sensor
 - *Evaluated for as long as 124-days, not compromised by biofilm formation*
- Enzyme-based amperometric glucose sensor
 - *Evaluated in a perfused bioreactor in three cell-based experiments*
- Optical oxygen sensor
 - *Evaluated in two 30-day bioreactor cell runs*



Microencapsulation Electrostatic Processing

- **Microencapsulation provides**
 - Better drug pharmacodynamics
 - New medical treatments for solid tumors and resistant infections
 - Improved drug delivery during chemotherapy treatment



Cooperative agreements between NASA and private industry

Space Act Agreements

Viragen- interferon production

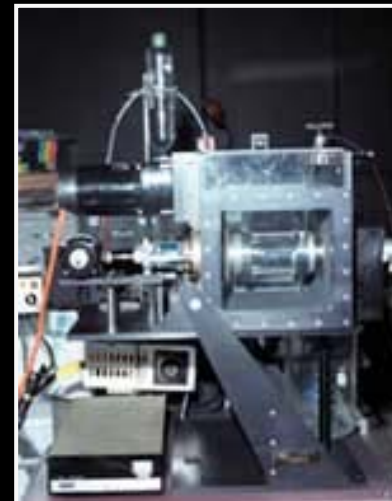
Fisk- reimbursable flight
experiments (via StelSys)

Wyeth-Lederle- efficacy of
candidate drugs using lung
mesenchymal cells



Cooperative Agreements

MOU with Biotechnology
Industry Organization



Summary

- Microgravity offers a unique environment that re-orders the forces exerted on cells
- The response of cells to the re-ordering provides novel insights into cellular mechanisms
- Cells unloaded from gravity may perform to our advantage in tissue morphogenesis
- The response of cells to microgravity provides the doorway 1) to understanding the the human experience in space, 2) to transitioning terrestrial life to low gravity environments, and 3) new strategies in applied science